How bad are changes in the Galactic environment for the evolution of life on Earth?

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In its motion through the Milky Way Galaxy, the Solar system encounters a "low"-density (≥100 H atoms cm^{-3}) Giant Molecular Cloud (GMC) approximately every 30 Myr, a "dense" (~2×10^3 H atoms cm^{-3}) GMC every ~10^9 years. However, there have been no studies linking such events with severe (snowball) glaciations or mass extinctions in the Earth history.

Here we show that during episodes when the Solar system is passing through moderately dense interstellar clouds (100 – 200 H atoms cm^{-3}) Earth experiences a dramatic increase

in the fluxes of the anomalous component of the cosmic rays (ACRs). The increased cosmic ray flux across the Earth's orbit would last as long as it takes to cross a moderately dense interstellar cloud, about 1 Myr years. A period of ~1 Myr is long enough for Earth to experience at least one magnetic reversal allowing penetration of the cosmic rays deep into the atmosphere even at low latitudes. Such increased cosmic ray fluxes would enhance the abundance of stratospheric NOx ~100 times between 20-40 km, which in turn would decrease the ozone column globally by at least 40% and in the polar regions up to 80%. Such an ozone loss would last for the duration of the magnetic reversal, several thousand years, and could trigger global extinctions.

We also show that for rare Solar system's collisions with dense GMCs dramatic cooling can be caused by interstellar dust accumulating in Earth's stratosphere which may trigger the runaway ice-albedo feedback that results in global Snowball glaciations.